Enhancing Interoperability Through Standard Procedures for Recording and Communicating Information on V&V Planning, Implementation and Results

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ABSTRACT

Decision makers need confidence that the models and simulations they use are fit to support their decision making process, such that their decisions are useful to their specific project or program. It is entirely possible and even quite likely, that individual models and simulations or those expressly for federate use are already available somewhere in the world. Users of these models, simulations or federates need to appreciate the Validation and Verification (V&V) effort already applied to the product, and to understand the level of impact originally anticipated for the product use. This effort can be difficult to represent and understand when use and re-use are required, and as such, time and further effort can be wasted in duplicating and discussing the recorded information about a product of interest. In mitigation to this, a standard approach to recording and documenting V&V information is introduced. The impact level of the original use is also a useful data item in understanding the V&V effort likely to have been exercised on the product. This information is usually lost or not even recorded, and can leave subsequent users with some uncertainty about the suitability of the product for their purpose.

1.0 INTRODUCTION

The high importance that Modelling and Simulation (M&S) now affords National and International activities is becoming increasingly obvious. The implementation of M&S activities requires the formulation of higher levels of understanding and information transfer between NATO, the PfP, Industry and National organisations. Verification and Validation is an area where information, data and the understanding of them is of primary importance. Without the understanding, the information is nothing, and the goals of re-use and interoperability are not possible.

This paper is organised as follows; section two reviews the need for information, understanding and interoperability, section three introduces the area of recording verification and validation information. The new International Test & Operating Procedure (ITOP) is then described in section four as a method for standardising the information from the V&V-related M&S activities. The methodologies behind the ITOP are discussed in section five. A summary entitled ‘I don’t care what you do, as long as you record it consistently’ fills section six, and there after follows the conclusions and references.

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2.0 INFORMATION, UNDERSTANDING AND INTEROPERABILITY

Human discourse is based on the sharing of negotiated representations, and as such the management and interoperability of models and simulations is grounded in communication practice [1]. These statements were made concerning the risks of using M&S in the field of Agronomy – soil management and crop production. The risks detailed are of surprising relevance to the military domain – failure to appreciate structure and assumptions, and failure to appreciate the reliability of the data and its formulation [1] to mention just two. The offer of resolution and mitigation is stimulated by the question "What kind of representation (of information) would help?" [1].

As the complexity of constructed models, and we would claim, their predictive power, continues to increase, it has become clear that efficient and informed flow of information between modellers will become increasingly important and even vital [2]. Again this is a statement about the need for the management of information about models and simulations – this time from the field of Computational Neuroscience. Following some research into what neuro-biologists felt would be useful to them, again a surprisingly relevant set of requests was found [2]. Of most relevance to this particular paper were ones concerning the importance that models had references to the literature and information on the experimental techniques from which the used data was derived, and that simulation parameters should be retrievable for future simulation work [2]. This has direct implications for model use, re-use and interoperability in our field as well as the above.

Research into knowledge management models [3] has shown that competitive, commercial and potentially military advantage is increased through the interoperability and sharing of explicit knowledge. In particular the sharing of what is described as 'meta-knowledge' about reusability is described as critical for competitive advantage. This meta-knowledge, I would suggest, is the sort of information described previously in [1] and [2] – experimental techniques, simulation parameters, data formulation, model structure and probably most importantly, the assumptions.

3.0 RECORDING VERIFICATION AND VALIDATION INFORMATION

The concept of meta-knowledge introduced above [3] can be seen to represent the information that should be documented as part of a robust verification and validation procedure. Every little piece of V&V effort should be recorded and communicated to the accreditation authority, such that they may be convinced of the appropriateness and correctness of the model or simulation [4]. The lack of this type of information, alternatively described as the 'complex macro statements' has been quoted in a number of studies as reasons for the unsuccessful completion of studies based on models and simulations [5].

The lack of a standard method for recording the meta-knowledge or macro statements about the V&V of a model or simulations has been cited a number of times as the reason why so much valuable data is not available for use and exchange. In [6] this is made explicit when the authors state that 'A common format for V&V reports would be helpful because we could then accumulate this type of information'. They go on to note that we will not 'soon see a community standard for information items or formats'. Even within the NATO Modelling and Simulation Group, it has been recognised that a key area for standardisation is the communication, interaction and data exchange between people or systems [7].

4.0 THE NEW INTERNATIONAL TEST & OPERATING PROCEDURE ON VERIFICATION AND VALIDATION OF MODELS AND SIMULATIONS

Based on the implementation of the four-nation Memorandum of Understanding (FR, GE, UK, U.S.) on the mutual acceptance of test and evaluation, the International Test and Evaluation Steering Committee (ITESC) oversees the standardisation and documentation of test operating procedures produced by specific

Working Groups of Experts (WGE). The work of the committee is divided into eight management areas of particular concern in test and evaluation of military materiel, such as vehicles, weapons/ammunition, aviation, missiles communications /electronics, etc. In 1997 the new area of Modelling and Simulation (M&S) was introduced and a Management Committee (MC7) was set up because of the increasing importance of integrating M&S into other ITOP areas. The role of MC7 is to provide a co-ordinated approach to the subject among its WGE and the ITESC and to the WGE of the other management areas.

Working group 7.2 has been focussing on the use of verification and validation, its main activities have been:

- Preparing procedure and guidance documentation on the optimum use of V&V for other WGE;
- Preparing procedure and guidance information on how to transfer information from the V&V process to other nations;
- Promoting the use of defined V&V frameworks in T&E;
- Assisting other WGE in their use of V&V as regards their own simulations;
- Reviewing research developments into methods and tools useable in V&V and to facilitate their adoption where applicable;
- Build a reliable basis for future Accreditation of models.

This has resulted in the production of an ITOP document which can be utilised across the M&S and V&V community, if the community wants it.

5.0 CONCEPTS BEHIND THE V&V ITOP DOCUMENT

This ITOP applies to the V&V activities associated with models, data, and model use (or, more correctly its simulation) which are intended to support primarily defence applications, particularly where the mutual acceptance of results and information derived from the M&S is a key consideration for the reciprocal procurement of defence equipment. This section introduces key concepts that are used in the ITOP [8], these are a “V&V cases” concept, a “claim-argument-evidence” structure, and a “levels” concept for the classification of M&S-use impact and V&V activities.

To promote the avoidance of unnecessary re-analysis and evaluation, achieved V&V information from three elements (data, model, and simulation) shall be documented in three separate cases. This separation is done because it was felt that these were the information ‘blocks’ which were most likely to be transferred and re-used.

The concept of a claim argument evidence structure arose from the need to record the justification and reasoning behind important decisions. The precise way in which a claim for accreditation is divided into multiple lower claims has to be explicit and traceable – this is called the argument. The sub-claims may also be divided in to further claims by further argument until a hierarchy of claim and argument has been constructed. Eventually, the lower level claims should be able to be substantiated by a piece of evidence obtained from the V&V effort.

A levels concept assists in communication and understanding between parties in discussion. It also provides a convenient metric for comparison purposes ensuring that there is some consistency and standardisation between the entities of interest and some frame of reference[4]. In the new procedure there are two types of level of consequence – the impact level that the M&S is to be used for (e.g. a level of commercial, project, or human impact that would be experienced from the mis-use of the product); and the level of effort (and therefore cost) required to undertake verification and validation activities in order to generate a requisite amount of confidence that the model, data, or simulation correctly satisfies its

purpose. There are obvious links between these two. A simulation used to predict kill/survivability rates would probably score a high impact level. As such it would likewise require a high level of V&V effort to provide evidence that it did behave appropriately.

6.0 I DON'T CARE WHAT YOU DO AS LONG AS YOU RECORD IT CONSISTENTLY

Documentation should be a normal part of modelling and simulation, for example some modern simulations do include their documentation on-line within the code [6]. This is a good situation as the information is likely to be current, controlled and will actually take up very little of a computer's storage capacity. A standardised or consistent format for this type of information electronic or hardcopy would be very helpful because the information would become easier to identify and could even be automatically read and accumulated [6].

The need for some generic document referred to as a 'logbook' has been identified as very useful [5], particularly for recording assumptions about the data, the model, the simulation run, or even just about the state of the real world. A document like this would have a number of potentially very important uses e.g.:

- An audit chain for decision making
- A structured walkthrough of the conceptual model [6]
- An assessment document for other applications
- An item of evidence to justify accreditation

The new ITOP aims to satisfy these requirements and uses by providing a template for such a document; a rationale for its use and some examples of how to apply the concepts discussed.

7.0 CONCLUSIONS

A new international standard for the recording of verification and validation effort has been constructed. It introduces several new concepts to this area including levels and the construction of reasoned arguments for accreditation. It is likely to have a dramatic impact on improving interoperability and communication between services, industry and nations. It will satisfy a requirement in the field of modelling and simulation for standardisation in this area.

Open distribution of this and any other ITOP is limited to FR/GE/UK/US Government agencies only. Requests from other countries should be referred to U.S. Army Developmental Test Command, ATTN: CSTE-DTC-TT-M Aberdeen Proving Ground, MD 21005-5055. In all cases the ITOP reference number and title should be quoted. Anyone can obtain a copy of an ITOP as long as there is no objection from the four countries.

8.0 REFERENCES

[1] P.G. Cox: "The Management of Models: Risks and Responsibility." Proceedings of the 9th Australian Agronomy Conference 1998.

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[3] H. Hatakama and T. Terano: "Two Organisational Knowledge-Sharing Models and Their Simulation Studies." The University of Tsukuba 2000.

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[7] E. Schwan: "The NATO Modelling and Simulation Group (NMSG) and the Role of M&S Standards." Proceedings of the NSMG Conference Breda, November 2001.

[8] "International Test & Operations Procedure 1-1-002 – Verification and Validation of Models and Simulations." ITSEC WGE 7.2 draft Issue January 2002.

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North Atlantic Treaty Organization
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The requirement for M&S V&V information management

- "There is a failure to appreciate model structure and assumptions, and a failure to appreciate the reliability of the data and its formulation"

  P. G. Cox: "The management of models: risks and responsibility." Proceedings of the 9th Australian Agronomy Conference 1998

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- "It is important that models have references to the literature and information on the experimental techniques from which the used data was derived, and that simulation parameters should be retrievable for future simulation work"

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The requirement for M&S V&V information management

- "A common format for V&V reports *would* be helpful because we could then accumulate meta-knowledge or macro statements about the M&S V&V"

D.J Cloud & L.B Rainey (eds): "Applied Modeling and Simulation : An integrated approach to development and operation." McGraw-Hill International Inc. 1998.

- "A key area for standardisation is the communication, interaction and data exchange between people or systems "

E. Schwan: "The NATO Modelling and Simulation Group (NMSG) and the Role of M&S Standards." Proceedings of the NSMG Conference Breda, November 2001.

International Test & Evaluation Steering Committee and Management Committee 7

(Modelling & Simulation)

- Based on the implementation of the four- nation Memorandum of Understanding on the mutual acceptance of test and evaluation, the International Test and Evaluation Steering Committee (ITESC) oversees the standardisation and documentation of test operating procedures produced by specific Working Groups of Experts
- The WGE are made up of experts in the particular field from all four member nations, who work together to produce International Test Operation Procedures

The role of an ITOP 1

- **Some of the many benefits include:**
  - Data can be reliably reused;
  - International co-operation & competition becomes much easier and more effective;
  - Duplication of testing is avoided;
  - There is confidence in components and systems tested;
- **ITOPs provide a convenient basis for defining test procedures in international contracts**

The role of an ITOP 1

- The work of the ITESC and the ITOPs Working Groups provide a valuable basis for these developments.
- In 1997 the new area of Modelling and Simulation was introduced and a Management Committee (MC7) was set up.
- Many ITOPs have been used as the basis for standard agreements (STANAGS) across the NATO community, leading to the larger scale standardisation of T&E practises.

WGE 7.2 Verification & Validation

- *Activities include:*
  - Preparing procedure and guidance documentation on the optimum use of V&V for other WGE;
  - Preparing procedure and guidance information on how to transfer information from the V&V process to other nations;
  - Promoting the use of defined V&V frameworks in T&E;
  - Reviewing research developments into methods and tools useable in V&V and to facilitate their adoption where applicable;
  - Build a reliable basis for future Accreditation of models.

Concepts behind the V&V ITOP document

- This ITOP applies to the V&V activities associated with models, data, and simulations which are intended to support primarily defence applications.
- These are the information ‘blocks’ which are most likely to be transferred and re-used.
- Achieved V&V information from three elements shall be documented in three separate cases.

Concepts behind the V&V ITOP document

- The concept of a claim argument evidence structure arose from the need to record the justification and reasoning behind important decisions.
- The precise way in which a claim for accreditation is divided into multiple lower claims has to be explicit and traceable – this is called the argument.
- Eventually, the lower level claims should be able to be substantiated by a piece of evidence obtained from the V&V effort.

Concepts behind the V&V ITOP document

- A levels concept assists in communication and understanding between parties in discussion.
- In the new ITOP procedure there are two types of level

> The impact level that the M&S is to be used for.

(e.g. a level of commercial, project, or human impact that would be experienced from the mis-use of the product)

> The effort level required to undertake verification and validation activities in order to generate a requisite amount of confidence.

Recording the V&V information

- The need for some generic document referred to as a 'logbook' has been identified as very useful, particularly for recording assumptions about the data, the model, the simulation and even the assumed 'real world'. A document like this would have a number of potentially very important uses e.g.
  - An audit chain for decision making
  - A structured walkthrough of the conceptual model
  - An assessment document for other applications
  - An item of evidence to justify accreditation

Recording the V&V information

- The new ITOP aims to satisfy these requirements and uses by providing
  - A template for such a document;
  - A rationale for its use;
  - Some examples of how to apply the concepts.

Obtaining ITOP information

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- Requests from other countries should be referred to U.S. Army Developmental Test Command, ATTN: CSTE-DTC-TT-M Aberdeen Proving Ground, MD 21005-5055. In all cases the ITOP reference number and title should be quoted.
- The ITOP on V&V reference number is **ITOP: 1-1-002**
- Anyone can obtain a copy of an ITOP as long as there is no objection from the four countries.

Thank you

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